GUIDE TO TROUBLESHOOTING LEGACY OPTO 22 PRODUCTS

Solid State Relays
G1 (Standard) I/O
G4 I/O
Pamux™
Optomux™
SNAP I/O™ Modules
Serial B3000 SNAP Brains

Form 1104-060713—July 2006

OPTO 22

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Guide to Troubleshooting Legacy Opto 22 Products

OPTO 22

Introduction

This guide addresses some of the technical issues that come up most often when troubleshooting and specifying legacy Opto 22 products, including SSRs, input/output (I/O) modules, Pamux and Optomux systems, and serial SNAP I/O systems. For Ethernet-based SNAP controllers and brains, consult the device's user's guide for troubleshooting information.

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About Opto 22 Product Support

Technical support for the life of the product is included with your purchase of any Opto 22 product. If you cannot find the help you need in this document or on our website (www.opto22.com), contact Opto 22 Product Support:

Phone:	800-TEK-OPTO (835-6786) 951-695-3080 (Hours are Monday through Friday, 7 a.m. to 5 p.m. Pacific Time)
Fax:	951-695-3017
Email:	support@opto22.com
Opto 22 Web site:	support.opto22.com

NOTE: Email messages and phone calls to Opto 22 Product Support are grouped together and answered in the order received.

Opto 22 Product Support should be contacted any time an otherwise unresolvable application problem arises in the field, any time clarification of specifications or system performance is required, any time a damaged or defective item needs to be returned for repair, or any time a question comes up that doesn't appear to be addressed in our documentation. Typical response times are within one business day.

Please have the model number of the product you need help with, as well as applicable software and firmware titles and versions when contacting us regarding such issues. Having easy access to any hardware in question while on the phone with our Product Support Group is also desirable.

In general, Opto 22 does not provide field technical support. If you feel that you require this level of service, we recommend that you contact one of our automation distributors. A list of distributors is available on our website, www.opto22.com.

Return and Repair Policy

In-Warranty Repairs

Most I/O modules and solid-state relays manufactured after January 1996 have a lifetime guarantee. Other products carry a 30-month warranty. In-warranty units will be repaired or replaced free of charge. See the Opto 22 Limited Warranty on our website for details. The repair does not extend the warranty beyond the original warranty period.

Out-of-Warranty Repairs

Any unit that is out of warranty will be repaired at a cost equal to half the current list price. This applies only to those units that can be repaired. The repaired unit will be given a 30-month repair warranty. The warranty period for out-of-warranty repairs of obsolete products will be 30 months or until repair parts are no longer available—whichever comes first.

Repair Returns

Prior to returning any product for repair or replacement, please contact Opto 22's Product Support Group (see page 1) to request an RMA number. In order to be processed properly, the RMA number must be on the shipping label when the package is received by Opto 22.

If you have any questions about the warranty status of your Opto 22 product, please contact Product Support.

Solid State Relays

Opto 22 has been the world's leading manufacturer of solid-state relays for more than 20 years and pioneered the design of the relay that is now almost universally used in the industry.

Our SSR product family spans current and voltage ratings from 2.0 A at 120 VAC to 45 A at 575 VAC, and 3.0 A to 5.0A at 60 VDC. Relays are available in three package styles. Control voltage is 3-32 VDC in most models, though selected products are available with 120 VAC nominal control voltage.

All relays feature 4,000 Vrms (1 sec.) optical isolation from field to control, and are, at a minimum, UL and CSA approved. AC switching models also typically feature built-in transient suppression to 0.5 power factor. MTTF rates for these products are typically greater than a million hours.

SSR Applications

Q: What is a solid-state relay?

A: An SSR is a semiconductor device that can be used in place of a mechanical relay to switch electricity to a load in many applications. Solid-state relays are purely electronic, normally composed of a low current "control" side (equivalent to the coil on an electromechanical relay) and a high-current load side (equivalent to the contact on a conventional relay). SSRs typically also feature electrical isolation to several thousand volts between the control and load sides. Because of this isolation, the load side of the relay is actually powered by the switched line; both line voltage and a load (as well as the control signal) must be present for the relay to operate.

Q: What are the advantages of using an SSR over a mechanical relay?

A: Many applications require a moderate amount of power (W to kW) to be switched on and off fairly rapidly. A good example would be the operation of a heater element in a controlled-temperature system. Typically, the amount of heat put into the system is regulated using pulse-width modulation turning a fixed-power heating element on and off for time periods ranging from seconds to minutes. Mechanical relays have a finite cycle life, as their components tend to wear out over thousands to millions of cycles. SSRs do not have this problem; in the proper application, they could be operated almost infinitely.

Q: What are the limitations of using an SSR?

A: SSRs have a few limitations when compared to the capabilities of their mechanical counterparts. First, because the relay is semiconductor-based, it will never turn all the way on, nor off. This means that in the "on" state, the relay still has some internal resistance to the flow of electricity, causing it to get hot. When in the "off" state, the relay will exhibit a small amount of leakage current, typically a few mA. This leakage can keep some loads, especially ones with a high impedance, from turning off.

Additionally, SSRs are more sensitive to voltage transients; while Opto 22 relays are very well transient-protected, if a relay gets hit hard enough a sufficient number of times, it will die or degrade. This makes SSRs less ideal for driving highly inductive electromechanical loads, such as some solenoids or motors. SSRs should also never be used for applications such as safety power disconnects, because even in the off state, leakage current is present. Leakage current through an

SSR also implies the presence of a potentially high voltage. Even though the relay is not conducting a large amount of current, the switched terminal will still be "hot" and thus dangerous.

Q: Do you make multi-pole or multi-throw SSRs?

A: Opto 22 manufactures only single-pole, single-throw SSRs. If multi-phase operation is required, just use a relay on each phase. Because of the limitations on semiconductor devices of the type used in SSRs, it is not practical to build single-device multi-throw SSRs. However, an alternative to multi-throw operation may be accomplished with multiple relays.

Q: Can I hook up SSRs in parallel to achieve a higher current rating?

A: No. There is no way to guarantee that two or more relays will turn on simultaneously when operated in parallel. Each relay requires a minimum voltage across the output terminals to function; because of the optical isolation feature, the "contact" part of the SSR is actually powered by the line it switches. One relay turning on before the other will cause the second relay to lose its turn-on voltage, and it won't ever turn on, or at least not until the first relay fails from carrying too much current.

Q: What does a "zero-crossing" turn-on circuit refer to?

A: "Zero-crossing" turn-on and turn-off refer to the point on the AC waveform when the voltage is zero. It is at this point that an AC SSR will turn on or off. All Opto 22 AC relays are designed with a zero-crossing turn-on and turn-off circuit. When the AC circuit voltage is at zero, no current is flowing. This makes it much easier and safer for the semiconductor device in the relay to be turned on or off. It also generates much less electrical EMI/RFI noise.

Q: Can I use an AC SSR to switch DC?

A: No. Because of the zero-crossing circuit described above, the relay will most likely never turn on, and even if it is on, it will likely not be possible to turn it off, as DC voltage typically never drops to zero.

Q: Can I use a DC SSR to switch AC?

A: No. The semiconductor device used in Opto 22's DC SSRs is polarized. It may break down and conduct for the portion of the waveform that is reversed in polarity.

Q: Can a DC SSR be used to switch an analog signal?

A: This is not recommended at all, for several reasons. First, the voltage drop across the relay will cause signal loss. Second, the conduction characteristics of the SSR are very non-linear at low operating voltages and currents. Use a mechanical relay; it will work much better.

Q: What agency approvals do your SSRs carry?

A: In general, Opto 22 relays carry UL, CSA, and CE approval. See our website for approval documents.

SSR Troubleshooting

Q: My SSR does not function anymore. What may have happened?

A: There is no "normal" mode of failure for SSRs. Most of the time they just stop working by refusing to turn on or off. An improper installation is often to blame for an SSR failure, as SSRs are very simple, reliable devices. If you have a failed SSR, it is important to look at the normal operating parameters of that relay within the larger system to make sure that the relay being used is appropriate to the application, and that the relay is being properly installed in the system. The three most common causes of SSR failure are:

- *SSR improperly matched to load.* The relay was destroyed by overheating from carrying too much current too long.
- *SSR insufficiently protected.* Remember, a semiconductor is less tough than a simple metal contact. Reverse voltages exceeding the PRV rating of the relay will cause damage. Voltage spikes on the switched line, perhaps from inductive kickback, destroyed one or more of the internal switching devices. Remember to use snubbers, transorbs, MOVs, and/or commutating diodes on highly inductive loads.
- *SSR improperly installed.* The SSR was not mounted to a large enough heat sink, or no thermal compound was used, causing the relay to overheat. Also, insufficient tightening of the load terminals can cause arcing and ohmic heating of the relay. Opto 22 recommends 15 to 16 inch-pounds of torque on the load screw terminals. Similar failures have also been attributed to the use of crimp-on terminal lugs or spades; make sure such terminals are tightly crimped, and even drip some solder into the joint to ensure good electrical contact and protection from corrosion.

Q: How can I test my SSR?

A: It is not possible to test an SSR by the same methods used to test mechanical relays; a typical SSR will always show an infinite impedance to a resistance meter placed across the output terminals. There are a few reasons for this. First, the SSR requires a small amount of power to operate, derived from whatever voltage source is placed on the load terminals. A typical multimeter will not supply sufficient voltage to cause the relay to change state. Second, AC SSRs contain a zero-crossing circuit, which will not allow them to change state unless zero voltage is applied. Most test equipment will supply a DC voltage to the relay, and the relay will thus never see the zero it requires to change state.

To test an SSR, it is best to operate it at the actual line voltage it will be used at, driving a load such as a large light bulb.

Q: I have an SSR driving a load. The load turns on okay but never seems to turn off, unless I remove power from the relay entirely. What might be happening?

A: This is normally a problem when using an SSR with a high-impedance load, such as a neon lamp or a small solenoid. Loads like these often have relatively large initial currents but relatively small "hold-in" currents. The result is that the off-state leakage current through the relay (see previous section) is insufficient to cause the load to turn on to start with, but sufficient to keep it on, once started.

The solution to this problem is to place a power resistor, sized for 8–10 times the rated maximum leakage current for the SSR, in parallel with the load. Make sure that this resistor has a high enough power rating for the application. For example, for a 5 mA leakage current at 120 VAC, a resistor drawing 50 mA would be desirable. Using Ohm's law, the resistor value becomes 2,400 Ohms. This resistor will dissipate 6 Watts, so a 7.5 or 10-Watt size power resistor should be used.

Q: I have a new AC SSR driving a solenoid. It turns on okay once but will not turn on again. What is going on?

A: Some solenoids, some types of halogen lights, and some types of strobe lights incorporate a diode in series with the coil or filament. This causes the light to behave as a half-wave rectifier. Opto 22 SSRs have a built-in R-C snubber circuit in parallel with the output. The capacitor in this circuit charges up but cannot discharge through the series diode, causing a voltage to appear across the SSR terminals. Because the SSR must see a zero voltage across the terminals to come on, it can't turn on again in this situation.

The solution here would be to put a high-value resistor (several tens of K ohms) across the terminals of the relay, to allow the capacitor to drain its charge.

Notes for All Opto 22 Analog I/O Families

About Transformer Isolation

Transformer isolation is important with analog signals to prevent ground loop problems (also referred to as common mode noise). Most analog signals are floating; that is, the signal common is not tied to earth ground. With these types of signals, transformer isolation is not necessary. However, if you have two analog signals and both are grounded—that is, their signal commons are tied to earth ground—then you may need transformer isolation.

Without transformer isolation, the signal commons for both analog channels are tied together at the rack through the analog modules (assuming the two channels are on the same rack). If each signal has its common tied to earth ground in different locations, and if earth ground is at a different potential voltage at these locations (which is normal), then there is a voltage difference between the two signal commons. This potential (or voltage) difference causes a "ground loop" current to flow between the two ground points and through the analog modules, which may interfere with the analog signal being measured.

Transformer isolation breaks the connection between the two analog modules and eliminates the path for the ground loop current to flow.

Sometimes customers are not familiar with this potential problem and consequently spend hours of troubleshooting time during or after startup, trying to figure out why the system is not working correctly. Sometimes a customer is familiar with this issue but doesn't realize that their ungrounded analog sensor is inadvertently grounded.

Isolation in Opto 22 I/O Families

Most SNAP analog I/O offers transformer isolation between modules but not between channels on the same module. However, isolated SNAP analog input modules are available with channel-to-channel isolation.

G4 analog I/O offers transformer isolation between each single-channel module.

High-density G4 analog I/O offers transformer isolation between the two interface cards but not between channels on the interface card and not between groups of channels on the interface card.

G1 (Standard) analog I/O modules offer transformer isolation only with the modules that have a "T" in the part number. G1 analog modules with a T at the end of the part number have isolation between each module.

Notes on Sourcing Current Loops (4–20 mA)

A few SNAP analog modules, such as the SNAP-AIMA-iSRC input and the SNAP-AOA-23-iSRC output, provide built-in isolated loop sourcing for both channels with the connection of a single 24 V power supply, such as the SNAP-PS-24 or SNAP-PS24U power supplies.

Most SNAP analog modules, however, do not have a built-in isolated loop excitation power supply, nor do they provide for a shared loop power supply. An external loop power supply (SNAP-PS-24 or SNAP-PS24U) is required. If one power supply is used for multiple loops, then the power supply will bypass any transformer isolation. The only way to maintain the isolation in this case is to use separate, isolated power supplies, one per loop.

G4 single-channel I/O modules G4AD3 and G4DA3 provide both transformer isolation and a built-in isolated power supply to source current loops.

High-density G4 analog I/O cards do not have a built-in isolated loop excitation power supply and do not provide for a shared loop power supply. An external loop power supply is required. There is no provision for transformer isolation except between the two I/O cards on the I/O unit.

G1 (Standard) analog mounting racks allow for a shared loop source power supply. Although this can be used with "T" modules, it defeats the purpose of having transformer isolation, because G1 analog "T" modules provide transformer isolation only for the analog signal and not for the loop power supply. The only way to maintain the isolation in this case is to use separate, isolated power supplies, one per loop.

G1 and G4 Digital I/O Families

In addition to our multichannel SNAP I/O modules, Opto 22 still makes two families of single-channel digital I/O products: the Standard (or G1 series), and the Generation 4, or G4 series. Opto 22 invented the first modular, optically isolated I/O product meant for use with computerized control systems; these G1 I/O modules introduced the familiar white-yellow-red-black color scheme. Since then, the G1 standard digital I/O family has been one of the most emulated industrial products in recent history.

Generation 4 was introduced in 1989 as a smaller, more integrated package. The performance of the two module families is essentially identical; the main difference is that G4 has the fuse and module status indicator LED built into the module. (On the G1, the protective fuse and indicator LED are built into the mounting rack.)

Because the performance and design of the two families is nearly identical, the following application and troubleshooting sections are applicable to both, except where noted.

G1 and G4 Digital I/O Applications

Q: Do you recommend one digital I/O family over another?

A: Opto 22 recommends that new users of I/O modules use our SNAP I/O™ (see page 24) unless design constraints do not permit its use. Opto 22 also recommends that current users of G1 and G4 modules take a close look at SNAP I/O for new installations. SNAP is more cost effective than G1 or G4 because it is much higher density; SNAP also offers much greater flexibility in network communications and control software.

If your application requires the use of G1 or G4 modules, unless there are other factors besides electrical performance, both families should perform equally well. Some modules are available in the G4 series that are not available in G1 or SNAP; these include extremely high-speed input modules and modules featuring the equivalent of hand-off-auto switches. The G4 output modules do use a fuse type that can be hard to find replacements for in more remote locations; though this is not normally an issue given adequate spare-parts planning. Module pricing for G1 and G4 is the same, so cost per point is not typically an issue for single-point modules.

Q: What sort of power supply requirements do these modules have?

A: Each G1 or G4 digital I/O module has two sides which are optically isolated from one another. The logic side requires a positive voltage supply somewhere close to the rated module voltage; a G4IDC5 would require 5 VDC, for instance. Current requirements on the logic side are about 10 mA for all types. The field side of Opto 22 modules is line powered. This means that for the circuitry to function, there must be a voltage differential across the field side terminals. This, of course, is not a problem for input modules, but it is important to keep in mind for the solid-state outputs. These outputs cannot change state without a voltage differential present, so the module cannot be treated as a simple dry contact. To operate properly, one side must be "wet" at all times.

Q: Your literature says that these modules operate in a "negative true" mode. What does this mean?

A: "Negative true" logic is the same as inverting logic. On Opto 22 I/O modules, this means that when the field side is "on," the control side is "off," and vice versa. Essentially, the module will invert any logical signal that is sent to it. Normally this is not a problem for microprocessor-based control systems, as inverting a logical signal is one of the easiest operations to perform on such a system.

Don't worry about replacing another manufacturer's modules with Opto 22's on this account—we've used negative true logic from the start, and most of the manufacturers who have copied our designs followed our negative-true standard. The reasons behind choosing negative-true

logic originally had to do with the performance of various semiconductor components; specifically current ratings of n-channel versus p-channel transistors.

Q: Is there a method by which these modules can be used in a non-inverting mode?

A: Output modules only may be used in a non-inverting, positive true logic mode, and only with certain types of module mounting racks. Please contact Opto 22 Product Support for further information.

Q: I need a dry-contact, mechanical output module. Do you make one?

A: Opto 22 manufactures three types of dry-contact output modules in the G1 and G4 series, denoted by an "R" suffix on the part number. These are the ODC5R, G4ODC5R, and G4ODC5R5. The "R" modules are normally open; the "R5" module is normally closed. All dry-contact modules are rated 10 VA maximum. They cannot be used in positive true applications and must operate at a 5 V logic level. If other logic levels or higher power handling is needed, Brentek International (www.brentek.com) manufactures dry contact modules almost exclusively; they have several types that are compatible with Opto 22 products.

Q: I currently have several modules made by another company installed in a piece of equipment. Can Opto 22 modules be used to replace them?

A: Typically, yes. Opto 22 makes a very wide variety of modules in both the G1 (0.6 inch-by-1.7 inch footprint) and G4 packages. Opto 22 does not currently make modules in the "M" or "SM" (0.4 inch-by-1.7 inch) style cases, though the G1-series modules are pin-compatible. If there is sufficient lateral space, G1 modules could be used here. Our competitor's part numbering schemes are very similar to our own; typically a "standard" package module will have no additional identifier, a G4 package module will have a part number containing the letter "G," and "M" and "SM" packages will also be identified by the respective letters in the part number. If you want to get an exact cross reference, please call Opto 22 Product Support and have ready the competitor's part number and a service description, for example, voltage and current rating.

Q: What agency approvals do your modules have?

A: Opto 22's I/O modules are, at a minimum, UL and CSA approved. Most modules are CE compliant. Certain models are also FM approved for use in Class I, Division II hazardous environments. For more information regarding agency approvals for specific models, see the agency approval documents on our website.

G1 and G4 Digital I/O Troubleshooting

Q: I have an I/O module that is not working anymore. What may have happened?

A: As with SSRs, there is no one way in which I/O modules fail. For one, input modules normally fail in a different way than outputs. Output modules normally fail open, or half-wave for AC, and the failure is usually caused by applying too much current or by degradation of the semiconductor switch by overvoltage.

Because the module is separated into two parts by the optical isolator, it is possible to have an output module that behaves properly on the logic side but is broken on the field side. In this case the

LED will usually continue to turn on and off as commanded by the driving logic device, even though the module has failed.

The first step to troubleshooting a failed module is to check the fuse. If it is blown, simply replacing it should get the module working again. If the module continues to blow fuses, analyze the load to see if the module is really suited to the application.

Input modules also typically fail on the field side, usually from overvoltage or overcurrent. Opto 22's basic AC and DC input modules contain a bridge rectifier, allowing hookup without regard to polarity. Other DC input modules require the input to be polarized correctly. All DC input modules are polarized. The first thing to check on a DC module that is not working is the polarity of the input signal. Unlike output modules, an input module's LED usually will not function as expected when the module has failed.

The logic side of Opto 22's I/O modules rarely fails. If it does, it's usually due to using the module at the wrong logic voltage or to miswiring.

Q: I have an input module that seems to "flicker" when a voltage is applied to it. What is happening here?

A: Because Opto 22's basic input modules contain bridge rectifiers, it is possible in an AC application to destroy one-half of the rectifier and still have the module function for a time. The bridge rectifier turns into a half-wave rectifier, causing the module to turn on and off at the line frequency when an input is applied.

Also, using a DC input module that does not contain a diode bridge on an AC circuit will cause flicker. This may be seen visibly as "flicker" on the status LED. Digital logic devices, being much faster than the human eye, can have serious problems with this failure mode.

This failure results most commonly in applications where the input module is placed in parallel with an inductive load. When the load turns off, the back-EMF goes right through the module, destroying one-half of the bridge. Placing a transorb or large R-C snubber in parallel with both the load and input module will significantly reduce the frequency of this type of failure.

Q: I have an output module driving a load. The load turns on okay but never seems to turn off, unless I remove power from the relay entirely. What might be happening?

A: Normally this problem occurs when using an output module with a high-impedance load, such as a neon lamp or a small solenoid. Loads like these often have relatively large initial currents but relatively small "hold-in" currents. The result is that the off-state leakage current through the module is insufficient to cause the load to turn on to start with, but it is sufficient to keep it on once started. The normal solution is to place a power resistor, sized for 8–10 times the rated maximum leakage current for the module, in parallel with the load. Make sure that this resistor has a high enough power (wattage) rating for the application.

Q: I have a new AC output driving a solenoid. It turns on okay once but will not turn on again. What is going on?

A: Some solenoids and some types of halogen lights incorporate a diode in series with the coil or filament, causing the light to behave as a half-wave rectifier. Opto 22 output modules have a built-in R-C snubber circuit in parallel with the output. The capacitor in this circuit charges up but cannot

discharge through the series diode, causing a voltage to appear across the output terminals. Because the module must see a zero voltage across the terminals to come on, it can't turn on again in this situation.

The solution here would be to put a high-value resistor (several tens of K ohms) across the output terminals of the module, to allow the capacitor to drain its charge.

Q: I have an AC output module in a circuit, wired in series (ANDed) with another contact. When that other contact closes, my load turns on momentarily, even though my output module is off. Is my module broken?

A: This situation arises when the output module does not see a voltage across its terminals. This is the case where another contact is wired in series with the module between the module and the "hot" side of the supply. Because the module is totally isolated from field to logic, the field (contact) side of the module must power itself from the attached line. By nature of the pilot circuit in the module, the switching semiconductor is in an indeterminate state when there is no voltage across the module. It may turn on for up to a half cycle if it suddenly receives power. The pilot circuit will realize that the module is on but cannot turn it off until the voltage crosses zero again.

There is no easy solution to this problem; typically a solution will involve either maintaining a minimal voltage across the module, pre-wetting it with a low voltage, or absorbing the energy from the half cycle turn-on with an R-C network in parallel with the load.

G1 and G4 Analog I/O Families

In addition to our multi-point SNAP I/O modules, Opto 22 still makes two families of single-point analog I/O modules: the Standard (or G1/Generation 1) analog series, used primarily with Optomux and Pamux, and the G4 or Generation 4 analog series, used primarily with our analog bricks and legacy M4 I/O controllers.

These modules provide a large variety of pre-packaged, pre-calibrated analog input and output options for a very large variety of signal types. Analog inputs include everything from standard 4–20 mA and 0–10 V industrial process signal inputs to thermocouples, RTDs, high current, millivolt, and even velocity inputs. Analog outputs are available to handle standard industrial process outputs such as 4-20 mA loops, as well as more specialized functions, such as time-proportional output for heater control.

The two module families are handled together in this document because they are extremely similar in their method of operation; in many cases, the only difference between a G1 module of a certain type and its G4 counterpart is the package.

Opto 22 analog input modules mount to Opto 22 mounting racks. Unlike our digital module families, the package and interface for our analog modules is essentially proprietary. Several other manufacturers use Opto 22 analog modules on their equipment, but there are no large suppliers of clone products. Generation 1 modules are typically mounted on G1 analog racks (for example., PB4AH, PB8AH, and PB16AH) and used with Optomux and Pamux brain boards. The B200 brain board is also designed for use with the G1 analog I/O, effectively giving the entire system the same flexibility and capability as the G4 analog series. G4 analog modules typically mount to analog bricks,

though Opto 22 does produce Optomux and Pamux brain board/rack combinations with the same physical characteristics as G4 bricks.

G1 and G4 Analog I/O Applications

Q: Do you recommend one analog module family over the other?

A: Yes, Opto 22 recommends SNAP I/O analog modules (see "SNAP Analog Applications" on page 26) over either Standard (G1) or G4 analog. SNAP offers higher density, higher resolution (inputs), lower cost, and additional options for network communications and control software.

As far as G1 and G4 modules are concerned, we don't recommend one module family over the other. Usually, the driving force behind the selection is what interface family is used—Pamux, Optomux, or mistic. The difference between the two module families is primarily physical; G4 may be installed at a 40% greater density but is typically more expensive. Some module types are available in G4 but not G1, including velocity, some thermocouple inputs, and the time-proportional output module.

Q: What type of power supply will I need for these modules?

A: G1 (Standard) analog modules require 5 VDC and ±15 VDC. G1 analog modules manufactured before 1993 may also require a -5 VDC reference. It is important that the 5 VDC supply be isolated (separate "common" terminals) from the ±15 VDC supply for G1 modules. 24–48 VDC may also be required to power current loops connected to G1 analog modules; this will depend on the type of external current loop devices being used.

Generation 4 analog modules require 5 VDC and 24 VDC. In G4 installations, the G4REG regulator is typically used to supply module power. G4 current loop modules are capable of sourcing 24 VDC for current loop applications. See Opto 22 form #1271, *Using Power Supplies with Opto 22 Systems*, for more information.

Q: Are Opto 22's current loop outputs active or passive?

A: Opto 22's current loop outputs (DA3, DA3T, and G4DA3) are passive; they require an external loop supply. The G4DA3 module can also supply 24 VDC for the loop; it may be connected so that it behaves as an active current-sourcing device or as a passive device, at your option.

Q: What type of A/D interface does a G1 or G4 analog input module provide?

A: Opto 22 analog I/O modules are not true analog-to-digital converters. Instead, each module contains a precision voltage-controlled oscillator (VCO) and outputs a frequency proportional to the input. Signal conditioning circuitry in front of the VCO guarantees that the correct gain and linearization is applied to whatever incoming signal the module is designed for.

The frequency output of the module is optically coupled to the brain board interface. A processing ASIC on the brain board then measures the incoming frequency and determines an appropriate count value from it. Over the module's normal operating range, an increase of 1 Hz on the module output is equivalent to a 1 count change in the input. This particular A-to-D methodology allows Opto 22 to provide effective conversion and isolation without having to use linear optocouplers or true serial A-to-D converters. This simplicity allows extremely high reliability. There is no conventional A-to-D converter used at any point in Opto 22's single-point analog I/O systems.

Q: What sort of interface does Opto 22 use for single-point analog output modules?

A: Opto 22's single-point analog outputs function very similar to inputs, except in reverse. The processor on the brain board sends a serial pulse train to the module, where it is converted to whatever output signal type the module was designed to supply. As with the input system, the use of a serial (pulse train) signal allows effective isolation through a standard optocoupler.

Q: Can I get information about how to use Opto 22 analog modules without Opto 22 brain boards for OEM applications?

A: Yes. Using the Opto 22 analog modules is not the same as using a conventional D-to-A or A-to-D converter. We think that it is easier and more economical. For an OEM, it moves the conversion process from a piece of hardware into processor software. While this potentially makes for a slightly longer code development cycle, it adds a great deal of flexibility to the end product. Software is easy to modify; hardwired circuits are not. Please contact Opto 22 Product Support for further information.

Q: What is the difference between your "T" modules and your normal analog modules?

A: The "T" suffix is used on G1 analog modules to denote transformer isolation. Normal G1 analog modules typically have a direct connection from the "common" field terminal through the internal circuitry of the module to the "common" terminal of the ±15 V power supply. Thus there is full optical isolation between the field and 5 V logic elements of the brain board, but there is no effective isolation between the field and the ±15 V analog module common. This is why Opto 22 recommends that the 5 V logic power supply for the brain board be isolated from the ±15 V supply for the same analog module.

In some installations, the lack of effective isolation between the field and power supply can cause the possibility of ground loops or common mode noise problems. "T" suffix modules, on the other hand, are transformer isolated; they contain a small inverter that couples power from the ±15 V supply to the analog module circuitry through a transformer. Thus with a "T" module, there is no direct connection between the field device and the logic or analog module power supply circuitry, eliminating the possibility of common mode problems in the system.

All G4 analog modules feature transformer isolation.

Q: When should I use a "T" module?

A: Opto 22 recommends that "T" modules be used in all applications, because they prevent the possibility of the most common application problems we see with analog modules. Installations where "T" modules would be absolutely required include systems using grounded thermocouples, non-isolated signal generators, or systems where there are long runs between the signal source and the signal receiver. At a minimum, a transformer-isolated analog module should be used anytime the possibility of a ground loop exists in the environment or in the installation. Examples of such environments would be metal plating or galvanizing plants, aluminum refining plants, or any environment where large currents are returned through the earth ground.

Q: What is the scale overrange capability of Opto 22's G1 and G4 analog input modules?

A: The over- and under-range capabilities of Opto 22's analog modules are dependent upon the type of module, although most modules will exhibit over-range capability from 10 percent to 100 percent

of scale. This large capacity is a result of the unique analog-to-digital conversion methodology used by Opto 22.

Keep in mind, however, that the same A-to-D process places a finite limit on resolution; when a module jumps into over-range operation, it loses roughly half of its precision. Total precision will be about 12 bits across the over-range span, as it is normally 12 bits across the normal operating span.

G1 and G4 Analog Troubleshooting

Q: How do Opto 22 G1 and G4 analog modules typically fail?

A: As a rule, Opto 22's analog modules don't fail when they are properly applied. Our failure rate for these modules is less than one one-hundredth of one percent, and approximately 99 out of every hundred of those failures is directly attributable to incorrect installation or some "act of God," such as lightning strikes.

Q: What sort of drift over time might I expect to see in one of these analog modules?

A: A small amount of drift (a few counts) is quite normal for analog electronics of the type found in Opto 22 analog modules. This can be especially evident if the module is operated near its rated temperature limits or undergoes extreme and rapid changes in temperature on a regular basis. Typically, drift of this type will be at most a percent or two over several years. Larger amounts of drift may indicate a problem with the application or installation of the module. Calibration maintenance should be performed in all measurement applications.

Q: My analog input module is returning a large negative number of counts even though I've measured my incoming signal, and it appears to be in range. What might be happening?

A: The normal cause of a problem like this is an insufficient power supply or insufficient isolation. Check to make sure that the 5 V and 15 V commons are isolated from one another. Also check to be sure that the 5 VDC supply is between 5.0 and 5.2 VDC, and that the ±15 volt supplies are accurate to within 0.25 V.

If you are reading a large negative value and you don't know what the signal input is, check it. Large negative numbers are the analog module's way of indicating an out-of-range condition. Also verify that the polarity of the field signal is correct with respect to the polarity of Opto 22 input module.

Q: The input from my module seems to be "noisy," changing value by several percent constantly. What can I do to prevent this?

A: Noisy analog readings are normally symptomatic of three things: a noisy input signal, a grounding problem, or a power supply problem.

Noisy inputs and grounding problems can be checked by looking at the input signal using an oscilloscope across the inputs of the module. If you see noise on the oscilloscope, then there is noise on the input line or the common line. The noise source should be located and eliminated, or at least filtered. A transformer-isolated module may need to be used, if one is not already being used.

If there is no noise on the input line, check the voltage on the ±15 VDC supply to the module. If the voltage on either rail is not 15 V ±0.25 V, the electronics within the module may not be functioning in a linear or stable fashion, leading to noise on the input.

If you can't identify a source of interference, please call Opto 22 Product Support. The G4AD3 is known to self-oscillate when driven by some types of current transmitters.

Q: Why will my G4AD3 4-20 mA input module not reach full scale?

A: The G4AD3 has a 3.3 V zener diode in series with the precision resistor used to generate a voltage signal from the current loop signal. This non-linear element will cause the effective loop source voltage to be 3.3 V less than the actual applied voltage. In a high-impedance loop, this may prevent the loop from ever reaching a full-scale current of 20 mA. Furthermore, the measured resistance across the module terminals will be nearly infinite, as most ohmmeters do not generate sufficient excitation voltage to bias the zener diode into conduction.

Note that the G1 AD3 and AD3T modules do not share this feature; they will measure an actual resistance of 249 Ohms.

Q: Is there a way to calibrate an analog input module?

A: Both the Optomux and mistic I/O systems have the ability to apply gain and offsets to both input and output modules on order to provide increased accuracy. In fact, the gain and offset commands typically must be used to make Opto 22's analog modules perform to book specifications, though the modules are quite good "out of the box." The gain and offset operations are actually performed at the brain board level, rather than at the modules themselves. The modules are not programmable, except at the factory prior to potting.

The Pamux family of equipment does not support brain board level offset and gain. Be aware that because the offset and gain are applied to the module signal after it has been digitized, any changes in gain and offset will also have a negative impact on module precision (resolution). The gain and offset commands should not be used for engineering unit conversion purposes.

Pamux Systems

Pamux was Opto 22's first computer-based I/O product family. Pamux is really an acronym that stands for PArallel MUltipleXed, which is essentially a description of what Pamux is: a parallel bus I/O communications system that allows many digital and analog I/O points to be addressed by a relatively small number of I/O lines from a computer bus.

The Pamux family consists of the following products:

- three Classic brain boards (B4, B5, and B6)
- two SNAP brains (digital-only SNAP-B4 and mixed analog/digital SNAP-B6)
- two adapter cards (the ISA bus AC28 and the PCI bus PCI-AC51)

SNAP and Classic I/O can be mixed on the same data link.

A PC with an AC28 card installed communicates with up to 32 brain boards, each with up to 16 I/O installed, up to 500 feet away. The PCI-AC51 comes with a free developer toolkit; the driver supports

up to 32 PCI-AC51s. This bus operates at an extremely high speed, making Pamux suitable for applications from simple warehouse bin lighting control to low-level interfacing with multi-axis, high-speed motion controllers.

Opto 22 manufactures several additional products compatible with Pamux but less frequently used, including the EX1 and EX2 daughter cards for the LC4 controller and the UCA4 universal parallel adapter. If you have an Opto 22 product that is believed to be part of the Pamux family but is not identified here, give Product Support a call.

Pamux Applications

Q: What are the advantages of using Pamux over a serial interface I/O system?

A: The primary advantage of Pamux over other I/O systems is its speed. The bus is theoretically capable of 200,000 send-receive transactions per second. This is about 80 times faster than a serial data link operating at 38.4 Kbaud. This means that with good driver programming, this bus is suitable for performing operations such as bringing a high-speed A/B-phased quadrature signal into a host computer—something not possible on a serial link without preprocessing.

Q: What are the limitations of the Pamux system?

A: The primary performance limitations of the Pamux system are two-fold. First, the bus length limit is 500 feet total, using 50-conductor ribbon cable. The ribbon cable itself is the second limitation. Because of the bus operating speed, cable impedance becomes a major concern. Shielded, bundled, rolled, or ground-plane ribbon cable does not work well with Pamux, leaving the unshielded, flat ribbon cable of the bus somewhat susceptible to noise pickup.

The signal duration on the bus is such that it is possible to have noise interpreted as signal; there is no error-checking provision in the Pamux bus protocol. Opto 22 has modified the Pamux brain boards to include some time-base digital filtering of the bus signals. These additions have made Pamux more noise-immune to moderate noise-level industrial environments.

The other potential problem introduced by the ribbon cable is that of physically running the bus cable; it is difficult to pull a 2.5-inch ribbon cable through conduit less than three inches in diameter. If the Pamux bus is to be run in conduit, plastic conduit should be used.

Q: Do other manufacturers support Pamux?

A: Pamux is an Opto 22 product, though there are many third-party manufacturers using Pamux within larger systems. Additionally, some manufacturers use the Pamux bus standard to add additional I/O capacity to their control systems. Hence, it is not uncommon to be performing maintenance on a machine and find a Pamux B4 brain board buried somewhere inside.

Q: Does Opto 22 supply software drivers for Pamux?

A: Yes, Opto 22 has an extensive set of object drivers and function libraries available for interfacing with a PCI-AC51 or an AC28 card, the PC adapter cards used to communicate with Pamux. Use the drivers with just about any modern programming language. They are available for MS-DOS, the Microsoft® Windows® family, and more recently, Linux®.

Q: Does Opto 22 have an HMI or control package that uses Pamux?

A: No. Opto 22 has not developed HMI or control software for the Pamux system. The driver tools mentioned in the previous answer may be used to create such a package using commercially available development languages such as Visual Basic® or Visual C++®. Some third-party HMIs have Pamux support.

Pamux Troubleshooting

Q: What are the most common causes of problems with Pamux systems?

A: The three most common causes of problems with Pamux systems are inadequate power supplies, electrical noise, and cabling problems. Together, these account for 80 percent or more of all problems the Opto 22 Product Support Group sees with Pamux system installations.

Revisions to the Pamux brain boards (B4, B5, and B6) included the addition of a voltage "watchdog" chip, which forces the board into reset mode if the power supply voltage moves out of a specified operating range. Pamux brain boards should be operated at 5.0 to 5.2 V, as measured across a capacitor on the brain board. Current requirements are 500 mA for all but the last board on the link, which requires 1,000 mA, plus the requirements of the installed modules, at about 10 mA each.

If the supply voltage is out of range and the voltage watchdog has forced the board into reset mode, both the "WD" and "ADDR" LEDs will be on. Normally, the operations causing these LEDs to light are mutually exclusive. Symptoms of power supply problems with Pamux equipment generally range from garbled data on multiple channels and improper operation of outputs, to periodic inability to communicate at all.

Bus noise problems typically cause periodic garbled data on multiple channels and/or improper output operation of multiple channels. Often, bus noise problems are due to the lack of proper termination at the end of the Pamux bus. Make sure a TERM1 terminator is correctly installed on the last board on the bus. If noise problems persist, use of a flat shielded or ground-plane ribbon cable and a TERM2 terminator may be an option, though Opto 22 does not recommend this. If shielded cable is used, the bus length will be limited to approximately 250 feet. Pamux will not function properly with braided, twisted, or rolled ribbon cable.

One last common cause of problems with Pamux equipment is inconsistency of jumper settings for the board reset level. All of the brain boards on the Pamux bus must be set to the same reset level, high or low. Typically, this problem is seen on new installations or when one or more brain boards have been replaced in an existing system. Power supply and noise problems may appear at any time and at any point in a system's life.

Q: How can I test my Pamux system?

A: Opto 22 has created software utilities that run on a PC for the AC28 and PCI-AC28. The utility for the AC-28, PAMSCAN.EXE, is available in a DOS or a Windows version. The utility for the PCI-AC28 is PamScan PCI. The utilities may be set to poll information from a given board address on the Pamux bus and also have the ability to "find" boards attached to a Pamux network. While this is often very useful, it does not work reliably on all types of computers, or on extremely old Pamux equipment. If the "find" command finds phantom boards or skips addresses, don't be too concerned. Instead, attempt to test each board manually.

Alternatively for DOS users, the DOS DEBUG utility may be used to directly write to the AC28 I/O port. While this can be very educational, it is not easy to do unless you are very familiar with DEBUG and the Pamux bus protocol. The relevant information may be found in chapter 4 in the Pamux User's Guide.

Q: I just replaced an older Pamux brain board with a new board, and now my system does not work. What might be happening?

A: Opto 22 added some time-based digital filtering to newer Pamux brain boards. While this should not be a problem with most systems, some third-party software drivers do not conform to the Pamux bus timing specification, or try to perform unsupported operations. Before the addition of the filtering, Pamux brain boards were not very selective in terms of what they considered valid data. It was possible in some cases to cause the bus to operate at a speed other than that specified, or to perform operations such as 16-bit reads and writes, effectively folding together read and write cycles. This is no longer possible. Any driver compliant with the Pamux bus timing specification will work with the new boards. If you suspect that the software driver may be at fault, contact the driver vendor for upgrade information.

A second possibility in this case is that the power supply voltage on the board is too low or, less likely, too high. Newer Pamux brain boards will not operate on voltages less than 4.85 V. If the voltage is low, both the "WD" and "ADDR" LEDs on the new brain board will be on.

Finally, some manufacturers who use Pamux brain boards in larger pieces of equipment modify the boards to suit their application better. Modified B4s are especially common. If you suspect a modified board, it is best to contact the company that the original equipment was acquired from to get information about replacements.

Q: I have a Pamux system attached to my PC. When the Pamux system is powered on, my computer boots just fine, but when the Pamux system is off, my computer refuses to boot properly. What is happening?

A: This is an extremely rare problem; usually it is caused by the use of a non-isolated power supply on the bus terminator. It is possible, right at powerup, for the remote supply to draw current off the PCI bus of the PC through the PCI-AC51, causing a momentary voltage sag. This sag may cause devices like network cards or hard disk controllers to initialize improperly. The only real solution is to unplug the Pamux system from the PC when it is not being used or to get an isolated power supply without much post-regulator filter capacitance.

Q: My Pamux system seems to occasionally get bad data or command outputs that the host computer did not command. What might be happening?

A: Pamux, having a relatively unprotected ribbon cable bus, is susceptible to external noise pickup. In extreme situations, this noise pickup can lead to inputs and outputs latching on or off or behaving randomly. Behavior like this is much more common with older Pamux equipment, as new board revisions have introduced basic filtering to the data lines. If you suspect you have a noise problem, please contact Opto 22 Product Support, and we will try to offer some solutions that will eliminate the problem.

Q: All the power lights on my Pamux equipment are on, but I can't communicate with it. The watchdog lights also come on a few seconds after powerup. Why won't this work?

A: The most likely cause of problems here is a mismatch between the reset level chosen by jumper on the brain boards and the value at the reset port address on the PC. Check to make sure that all reset levels are the same at all brain boards and that the correct value is present on the PC reset port. Occasionally there is a conflict between the reset port address on the computer and another system device; a few different reset addresses might need to be tried.

Optomux Systems

Optomux refers to a data protocol as well as a family of Opto 22 data acquisition and control products. Opto 22 developed the Optomux system in the early 1980s as a serial I/O system. More recently, newer hardware and a new driver toolkit offer customers the ability to use either serial or Ethernet networks with the Optomux protocol. The Optomux protocol has been so successful that it has become a standard protocol for serial data acquisition systems worldwide.

The original Optomux family included two brain boards, the digital B1 and the analog B2. These have been replaced by the digital E1 and the analog E2, which offer both serial and Ethernet capability. The serial B3000 SNAP brain also can be used with the Optomux protocol.

Optomux Applications

Q: What are the advantages of using an Optomux I/O system?

A: Optomux is a cost-effective, powerful, modular system for monitoring and controlling moderate amounts of I/O. The serial data link, while not extremely fast, is very reliable over distances up to 4,000 feet. Because the communications line can be shielded, it is suitable for use in just about any environment. Given its power, the Optomux ASCII protocol is extremely simple to use. Many third-party HMI and control packages have a driver to support the Optomux protocol.

Q: What are the limitations of the Optomux system?

A: The primary performance limitation of the Optomux system is the serial data link. While this link is very secure and completely error-checked, it is not as fast as a parallel link like Opto 22's Pamux system uses.

Over a serial network, the maximum baud rate supported by the Optomux brain boards is 38.4 Kbaud; the maximum usable baud rate for a given system is also typically dependent on the length of the communication lines. In theory, at maximum speed, the Optomux system should be capable of polling roughly 3,400 digital positions per second, or roughly 600 analog positions per second. However, that's assuming that all the positions are on the same brain board, which is not possible with Optomux. A more realistic speed figure would be about half of the previous numbers. For faster serial data communication, Opto 22's mistic protocol and hardware may be used at speeds to 115.2 Kbps. Or a B3000 brain using the Optomux protocol can communicate at similar high speeds.

Q: What comprises an Optomux system?

A: An Optomux system is typically made up of three main elements:

- A host device to poll the Optomux brain boards
- One to 255 brain boards
- I/O mounting racks carrying the individual I/O modules, to which the brain boards are attached.

Q: Does Opto 22 have software support for Optomux equipment?

A: Opto 22 provides the Optomux Driver Toolkit, used to develop custom applications in Visual Basic or C++. In addition, Opto 22 has a generic Optomux driver that may be used with almost any C compiler on just about any processor platform, though this driver does not have built-in serial communications handling.

Opto 22 does not have a software package specifically developed for the Optomux family. However, because the Optomux ASCII serial protocol has become an industry standard, many HMI and control interface software packages are available with Optomux drivers.

In addition, E1 and E2 brain boards running on an Ethernet network can use the following software:

- custom applications using Modbus/TCP
- custom applications using the OptoMMP protocol (Opto 22 provides the OptoMMP Communication Toolkit for this protocol.)
- integration with systems using Opto 22's ioProject, a complete software suite including control and HMI development tools plus an optional OPC server (ioProject software uses the OptoMMP protocol.)

Q: Can I use Optomux on a 2-wire RS-485 serial link?

A: In theory, it should be possible, but Opto 22 does not recommend or support Optomux used in 2-wire mode. This means that if you use 2-wire, we won't be able to help if you have a problem. If you want to use 2-wire RS-485 communications, Opto 22's mistic protocol and equipment is designed for 2-wire.

Q: Is it possible to put other serial devices on the Optomux network?

A: Yes, this is possible as long as the devices are tolerant of the Optomux protocol, and as long as the serial device's communications protocol can be ignored by the Optomux brain boards. All valid Optomux host messages begin with ASCII character 62 (>); all other messages on the link will be ignored. As long as character 62 is not used by the additional serial device, everything works.

Opto 22 also makes an addressable interface converter called the AC31 (Part numbers AC31A, AC31B, AC31C). This device lets messages be sent to RS-232 devices connected to the RS-422/485 network. More than one AC31 can be installed on the network, since they are addressable like Optomux brain boards. Essentially, the host sends an ASCII message to the AC31, framed by an Optomux style packet. The AC31 strips off the header and checksum elements of the packet, and passes the rest of the message to the RS-232 device.

Q: Does Opto 22 make a power supply for Optomux equipment?

A: Opto 22 manufactures a series of power supplies usable with digital Optomux equipment. They are the PBSA (120 VAC), PBSB (240 VAC), and PBSC (12/24 VDC). The power supplies attach to contact points on Opto 22 "H" suffix digital I/O module racks and will sit under a brain board if one is installed. Opto 22 does not have a power supply for analog I/O systems.

In any event, a well-regulated linear supply should be chosen, with careful attention paid to be certain the supply can meet the needs of the brain boards and the modules. Please see Opto 22 form #1271, *Using Power Supplies with Opto 22 Systems*, for more information.

Q: Will old Optomux equipment work with new Optomux equipment?

A: Yes; current Optomux hardware will work in conjunction with old Optomux equipment with no problem at all. One word of caution, however; over the years, new commands have been added to the Optomux protocol. New boards still support the old commands, but old boards may not support the new commands. Thus, new Optomux driver software may not necessarily function with old Optomux brain boards.

Q: Are E1 and E2 brain boards really drop-in replacements for B1s and B2s?

A: Yes, E1 and E2 brain boards were specifically designed with features identical to B1s and B2s, while adding Ethernet capability. E1s and E2s should work with your current Optomux software applications without modification.

Q: Is analog Optomux available with more than 12-bit resolution?

A: At one time, there existed a 14-bit version of analog Optomux. Opto 22 does not offer this anymore, due to some technical problems with the design. Currently, all Optomux is 12-bit resolution, plus half-resolution over-range.

Q: Can I use my Optomux system with mistic equipment?

A: Yes, though the two protocols will not coexist on the same serial data link. mistic brain boards use a binary protocol on a 2-wire RS-485 link as a default; Optomux will not function in this mode. Opto 22 does have a set of subroutines available for the mistic 200 controllers, allowing them to communicate with Optomux brain boards through the mistic controller's built-in serial ports.

Q: Is there a controller available to work with the Optomux system?

A: Yes. For a serial system, the LC4 controller supports Optomux. It has a built-in BASIC compiler and a built-in Optomux driver. BASIC programs can be written in the Microsoft Windows Notepad application. They must be saved with the .txt extension in order to download properly. Files can be downloaded using the LC terminal utility.

In addition, controllers running ioProject software, such as SNAP PAC controllers, can work with Ethernet-based Optomux systems using E1 and E2 brain boards. Note that the digital and analog features available on these brain boards differ depending on the protocol used (OptoMMP, Optomux, or Modbus/TCP. ioProject is based on the OptoMMP protocol.). See Opto 22 form #1546, the *E1 and E2 Brain Board Data Sheet*, for specifics.

Optomux Troubleshooting (Serial Network)

The following standard procedures for customers to use when troubleshooting Optomux over a serial network should be able to identify 80–90% of field problems. For E1 and E2 brain boards on an Ethernet network, see troubleshooting information in Opto 22 form #1563, the *E1 and E2 User's Guide*.

For serial networks, if you are receiving communications errors, see the section below. If you have no communication, see "No Communication (Serial)" on page 23. General questions and answers for Optomux begin on page 23.

Communications Errors (Serial)

1. Make sure that the 5 VDC power supply is secure, between 5.0 and 5.2 volts DC, and has no ripple. This should be checked at all the Optomux brain boards, across a capacitor on the board itself, not across the power supply terminals. If possible, inspect the power supply voltage with an oscilloscope, instead of using only a multimeter. Multimeters sometimes do not catch fast AC signals and transients.
2. Make certain the 5 VDC supply common is not connected to earth ground. Also make sure that the COM terminal on the RS-422/485 is not connected to earth ground and that any shields attached to this terminal are also non-grounded. If a communications wire shield is grounded, it must not be terminated on any of the brain boards.
3. If more than one 5 VDC power supply is used, make certain that all the commons are connected together. Normally, this is done through the logic ground or COM terminals on the communication lines.
4. Make sure the communications cable is daisy-chained from board to board; no Ts are allowed under the RS-422/485 specification.
5. Make certain both ends of the communications cable are properly terminated. The last brain board on the physical link must have jumpers A0 and A6 installed. The AC24AT and AC422AT must have jumpers B2, B4, B5, and B6 installed; LC4s should have jumpers 1 and 2 in the communications group installed.
6. Make sure that shielded twisted pair cable is used for communications links. Two pairs are required by Optomux. If the shield is to be earth-grounded, make sure it is not also connected to logic ground and that another conductor is used for logic common. If the shield is used for logic common, it is no longer a shield. Make sure that it is tied into all the logic ground/logic common terminals, but not earth ground.
7. Make sure the communications pairs are not crossed. In some types of cable, one wire from each pair is the same color. This makes it very easy to get those wires mixed up. If the jacket and shield are stripped back far enough, it will become obvious which wire belongs to which pair, unless the cable is not a twisted pair like it should be.
8. Make sure that the 5 VDC supply common is not connected to the ±15 VDC common terminal on analog boards; this can cause analog readings to be unstable.
9. Try running the system at a slower baud rate.
10. Try to test out the system using one of the OptoScan utilities. These utilities, covered below in the questions section, have error trapping ability. Often, the errors received can help determine

where the problem might lie. If OptoScan works properly, the problem is likely to be caused by the host software being used in the Optomux system.

11. Call Opto 22 Product Support.

No Communication (Serial)

1. Make certain that the baud rates and addresses are set correctly. No two boards on the same network should have the same address, and all boards (plus the host device) must be operating at the same baud rate. If you see receive lights flickering on the brain boards but do not get transmit lights back, the problem can be an incorrect baud rate or address setting on one or more brain boards, a bad cable, or low or noisy power on the brain.
2. Check the polarity of the + and – communication lines. If you have one or more receive lights stuck on, this is likely the cause.
3. Re-check the communications wiring. You can check the communications wiring in a multidrop system simply by measuring the impedance across the + and – lines of each wire pair. If the last board is terminated properly, you should see about 220 ohms. Make certain that in a multidrop system, only the last physical board has A0 and A6 installed.
4. Make sure that CTS handshaking is disabled on the host, or if that is not possible, jumper RTS to CTS. If RTS/CTS handshaking is enabled, the host may not even transmit on the serial data link.
5. Make sure that there are no port or IRQ conflicts on the host. If the host device is a PC, it is possible to verify the operation of the RS-422/485 port by jumping TX+ to RX+, and TX- to RX- (these are TO and FO on Opto 22 cards). A communications program such as Windows Terminal or HyperTerminal may be used to communicate with the port; in Terminal, make sure the terminal is set up with no flow control and that the local echo is turned off. Once started, anything typed on the keyboard should be displayed on the screen. If this does not happen, there may be a hardware or configuration problem with the communication port. Also remember that Opto 22 serial cards do not use standard communication port base addresses or IRQ lines for COM3 and COM4. Make sure that the host software is using the correct base address and IRQ.
6. Call Opto 22 Product Support.

Optomux Q&A

Q: Does Opto 22 have any troubleshooting software for the Optomux system?

A: Yes. Opto 22 has two applications for troubleshooting an Optomux system attached to a PC: the OptoScan (OSWIN32.EXE) and Omuxuser (Omuxuser.exe) utilities. Visual Basic source code is also available for these two Windows applications as an example of how to use Opto 22's Optomux driver DLLs.

Each of these applications includes the ability to manually configure and poll a digital or analog brain board, as well as the ability to scan for attached brain boards at various baud rates and addresses. They also have an error-trapping utility and a utility that lets you compare brain board jumpers given manually input data with the jumpers actually installed in the field. These applications are available on Opto 22's website.

Additionally, ioManager can be used to troubleshoot E1 and E2 brain boards that have an Ethernet connection. For information, see the Troubleshooting chapter in Opto 22 form #1563, the *E1 and E2 User's Guide*.

Q: Can I test the Optomux brain boards using the TEST jumpers?

A: No. The test jumpers are used by a specialized test fixture at Opto 22's manufacturing facility. There is no meaningful way to use the TEST jumpers without the test fixture.

Q: Why does the power light on my Optomux brain board not come on, even though I have 5 VDC attached to my rack?

A: Make sure that your rack is one with an "H" suffix on the part number. I/O racks without the "H" suffix may not have the correct onboard connections to supply power to the brain board. For example, the G4PB16 has a header connector that will accept a B1 brain board, but it has no power connections to this header. Thus, the brain board will not get power. A G4PB16H rack is physically similar but does have the power connections and thus will work properly with a B1. The reason for the two types of racks is simple: when connected directly through a ribbon cable to a PC with a G4AC5 adapter, it is not desirable to have the racks' 5 VDC supply connected to that on the computer's bus. This connection would be made (and damage could result) if a G4PB16H rack was used with the G4AC5.

SNAP I/O Modules

While not a legacy product, SNAP I/O modules are included in this guide because many of them are used with the serial SNAP B3000 brain as well as with the most recent Ethernet-based SNAP brains and on-the-rack controllers. The SNAP I/O family was introduced by Opto 22 in 1996, in response to the growing need for extremely high-density digital and analog I/O with high performance. SNAP provides Opto 22 I/O quality in a lightweight, extremely modular, high-density package.

A typical SNAP I/O installation consists of a SNAP mounting rack, SNAP modules, and a SNAP brain or on-the-rack controller. SNAP racks can be mounted directly to panel backplanes or to standard 35-millimeter symmetrical DIN rail, using the optional SNAP-RACKDIN adapter clips. SNAP mounting racks are available in 4-, 8-, 12-, and 16-module capacities. A unique locking system allows the secure attachment of the modules to the rack without requiring hold-down screws; however, screws can be used for applications requiring them.

SNAP digital modules are either 4-channel or 32-channel, but those used with a serial B3000 brain all have four channels. SNAP analog modules range from one to eight channels, but the serial B3000 brain is compatible with only the single- and dual-channel models.

SNAP Digital Applications

Q: What is the difference between SNAP digital modules and their G1 and G4 digital counterparts?

A: The main difference is that SNAP modules each contain at least four channels of input or output. (High-density digital SNAP modules contain 32 channels, but these must be used with Ethernet-based brains and controllers). SNAP outputs on four-channel modules also feature a standard glass or ceramic fuse, instead of the button fuses and pico fuses used in the other digital I/O families. These fuses are much more common, so it is much easier to find replacements for them.

Some SNAP digital output modules do not have channel-to-channel isolation; this means all four channels within the output module share a common connection terminal. Other SNAP digital output modules with part numbers ending in -i do have channel-to-channel isolation.

Q: What is the difference between the SRC and SNK digital DC output modules?

A: SRC and SNK stand for SouRCing and SiNKing, respectively. Because one fuse is used for all four output channels on the module, Opto 22 designed two different varieties. The selection of the module type depends on which side of the load the module is placed on. Typically, a SRC module is used between the + terminal and the load, while a SNK module would be used between the load and the –, ground, or common terminal. Please note that if the wrong module is used in the wrong place, all four channels will effectively become common and all four loads will be activated if any one channel is turned on.

Q: Why is there only one digital AC output module, when there are two DC modules?

A: Only one AC module design is required, because the switching devices used in the AC module are non-polar, unlike the transistors used in the DC modules. So the AC module may be used for sourcing or sinking, as long as all four channels on the module are wired in the same way.

Q: Is there any way to get more than 0.75 A current capacity out of each channel on the digital output module?

A: Yes. SNAP digital output modules are not rated on a channel-to-channel basis; instead, the entire module is rated for a maximum of 3 A. Any one channel on the module can carry up to 3 A, as long as the total current being carried by the module is 3 A or less. Thus, two of four channels can be used to carry 1.5 A each, with two channels unused.

Q: Can I wire the channels on a SNAP digital output module in parallel to obtain a higher current rating?

A: This question is related to the question above. There really isn't a need to wire channels in parallel, because each channel can carry up to 3 A; just be certain that the total current passing through the module is 3 A or less. Wiring the channels in parallel will not make any difference as far as performance goes; one channel will likely activate before the others and thus take up the entire load itself anyway. Parallel wiring does allow for some automatic fallback redundancy in case one channel fails open, however.

Q: Is there a SNAP digital input module for DC voltages over 32 V?

A: Yes. SNAP AC input modules may be used for DC input up to their voltage rating. For example, a SNAP-IAC5 can be used to read 125 VDC input signals. Most SNAP input modules use a full-wave rectifier on the input, allowing the module to be used as an AC or DC input and making it resistant to reversed-polarity installations.

Q: Is there a way to read low-voltage AC signals with a SNAP input module?

A: Yes. In the same way that SNAP AC modules can be used for DC, some SNAP DC modules can be used to take low-voltage AC signals, such as the 24 VAC commonly used in HVAC systems. This is allowable with all SNAP DC modules containing a full-wave rectifier.

Q: Does Opto 22 make a SNAP digital input module for high-speed signals? Or for quadrature input use?

A: Yes, and we offer many other digital input modules as well. For a complete list, see the Opto 22 website.

Q: What sort of isolation is provided by Opto 22 SNAP digital modules?

A: SNAP digital modules are optically isolated against transient voltages to 4,000 Vrms between the field and logic connections. Input modules are isolated up to 300 VAC between each channel on the module. There is no isolation from channel to channel on most digital output modules, due to the common connection on each module for fusing purposes, but isolated output modules are available.

Q: Which Opto 22 product families can SNAP digital I/O be used with?

A: SNAP digital I/O is used with all SNAP Ethernet-based brains and on-the-rack controllers, including SNAP PAC R-series controllers and SNAP Simple, Ethernet, and Ultimate brains. Most SNAP digital I/O modules can also be used with mistic and Optomux with the serial B3000 brain board. The SNAP-B4 brain allows SNAP to be used with Pamux. SNAP digital I/O can also be used directly with a PC through the G4AC5 interface card (24 channels).

SNAP Analog Applications

Q: What types of SNAP analog modules are available?

A: The software-configurable SNAP analog modules handle a wide variety of signal types, including voltage, current, rate, temperature, RMS, and more. New modules are added frequently, although many new modules require an Ethernet-based brain or on-the-rack controller. See the Opto 22 website for models and specifications.

Q: What type of resolution do SNAP analog inputs provide?

A: SNAP analog input modules have a typical resolution of ±25,000 counts. This equates to roughly 14.5-bit resolution plus sign, or 15.5-bit full-scale resolution. These odd resolutions are a result of the inherent accuracy of the input amplifiers used to buffer the analog-to-digital converter from the signal source. While the analog-to-digital converter may be capable of providing higher resolution

numbers, they are essentially useless because of the precision level of the signal conditioning circuitry and the amount of noise inherent in any electrical signal.

Q: What type of resolution do SNAP analog output modules achieve?

A: SNAP analog outputs are 12-bit resolution, yielding 4,095 counts from zero to full-scale.

Q: How much isolation do SNAP analog modules provide?

A: SNAP analog modules are transformer and optically isolated to 4,000 Vrms between the module and the rack/brain. Most SNAP analog modules are not isolated between channels; the channels share a common return connection. However, isolated analog modules are available. (For more information on isolation, see page 6.)

Q: How does a SNAP analog module interface to its host device?

A: Opto 22 designed SNAP analog modules to be extremely flexible in terms of how they interface to external devices; they can be used with a SNAP brain or on-the-rack controller, but a dedicated processor is not required. This makes them ideal for use in OEM applications. Instead of using a frequency output to a host brain board, SNAP analog uses an ARCNET-based packet protocol implemented on a serial two-wire RS-485 network. This means that any device with an RS-485 port can theoretically be used to communicate directly to the SNAP analog module. In addition, the modules can be programmed for report-by-exception operation, with one deadband, a HiHi, and LoLo report levels being user-programmable. These features make SNAP analog I/O extremely flexible for OEM users of Opto 22's SNAP equipment.

For more information about interfacing to a SNAP analog module, contact Product Support.

Q: What Opto 22 data acquisition families is SNAP analog compatible with?

A: SNAP analog I/O can be used with any SNAP Ethernet-based brain or on-the-rack controller, including SNAP PAC R-series controllers and SNAP Simple, Ethernet, and Ultimate brains. Many SNAP analog I/O modules can also be used with mistic and Optomux protocols using a serial B3000 brain or with the Modbus protocol using the SNAP-B3000-Modbus brain.

SNAP Digital Troubleshooting

Q: I have a SNAP digital module that has ceased to function. What may have caused this?

A: Loss of function in a SNAP digital module is normally caused by misapplication. As with Opto 22's other digital I/O module families, there is no one way in which SNAP I/O modules fail. Output modules normally fail in a different way than inputs.

Output modules usually fail open, or half-wave for AC, and the failure is normally caused by the application of too much current or by degradation of the semiconductor switch by overvoltage.

Because the module is separated into two parts by the optical isolator, it is possible to have an output module that behaves properly on the logic side but is broken on the field side. The LED will in most cases continue to turn on and off as commanded by the driving logic device, even though the module has failed.

The first step to troubleshooting a failed module is to check the fuse. If it is blown, simply replacing it should get the module working again. If the module continues to blow fuses, analyze the load to see if the module is really suitable to the application.

When input modules fail, they usually do so on the field side, typically from overvoltage or overcurrent resulting from overvoltage. Opto 22's SNAP AC and DC input modules contain a full-wave rectifier (as opposed to the G1 and G4 modules, which contain a bridge rectifier), allowing hookup without regard to polarity. Unlike output modules, an input module's LED normally will not function as expected when the module has failed.

Failures on the field side of all types of Opto 22 digital I/O modules occur extremely rarely and are typically the result of misapplication. The logic-side failures of Opto 22's I/O modules are also extremely rare. Usually, a failure of the logic side is attributable to using the module at the wrong logic voltage or to miswiring.

Q: I have an input module that seems to "flicker" when a voltage is applied to it. What is happening here?

A: Opto 22's basic input modules contain full-wave rectifiers. In an AC application it is possible to destroy one-half of the rectifier and still have the module function after a fashion. The full-wave rectifier turns into a half-wave rectifier, causing the module to turn on and off at the line frequency when an input is applied. This may be seen visibly as "flicker" on the channel status LED.

Digital logic devices, having much faster detection times than the human eye, can have serious problems with this failure mode. For example, a digital counter attached to a failed module will count at the input frequency.

This failure occurs most commonly in applications where the input module is placed in parallel with an inductive load. When the load turns off, the back-EMF goes right through the module, destroying one-half of the bridge.

Placing a transorb or large R-C snubber in parallel with both the load and input module will significantly reduce the frequency of, or eliminate entirely, this type of failure.

Q: I have an output module driving a load. The load turns on okay but never seems to turn off, unless I remove power from the relay entirely. What might be happening?

A: This problem may occur when using an output module with a high-impedance load, such as a neon lamp or a small solenoid. Loads like these often have relatively large initial currents but relatively small "hold-in" currents. The result is that the off-state leakage current through the module is insufficient to cause the load to turn on to start with, but sufficient to keep it on once started.

The solution to this problem is to place a power resistor, sized for 8–10 times the rated maximum leakage current for the module, in parallel with the load. Make sure that this resistor has a high enough power rating for the application.

Q: I have a new AC output driving a solenoid. It turns on okay once, but will not turn on again. What is going on?

A: Some solenoids and some types of halogen lights incorporate a diode in series with the coil or filament. This causes the light to behave as a half-wave rectifier. Opto 22 output modules have a built-in R-C snubber circuit in parallel with the output. The capacitor in this circuit charges up but

cannot discharge through the series diode, causing a voltage to appear across the output terminals. Because the module must see a zero voltage across the terminals to come on, it can't turn on again in this situation.

The solution is to find a lamp or solenoid that does not have an internal diode; a potential work-around would be to put a high-value resistor (several tens of KOhms) across the output terminals of the module, to allow the capacitor to drain its charge.

Q: I have an AC output module in a circuit, wired in series (ANDed) with another contact. When that other contact closes, my load turns on momentarily, even though my output module is off. Is my module broken?

A: This situation arises when the output module does not see a voltage across its terminals. This occurs when another contact is wired in series with the module, between the module and the "hot" side of the supply. Because the module is totally isolated from field to logic, the field (or contact) side of the module must power itself from the attached line. By nature of the pilot circuit in the module, the switching semiconductor is in an indeterminate state when there is no voltage across the module. It may turn on for up to a half cycle if it is suddenly "wet." The pilot circuit will realize that the module is on, but it cannot turn it off until the voltage crosses zero again.

There is no easy solution to this problem. Typically a solution will involve either maintaining a minimal voltage across the module, pre-wetting it with a low voltage, or absorbing the energy from the half-cycle turn-on with an R-C network in parallel with the load.

Q: Why are all four loads connected to my SNAP output module coming on when I'm activating only one of the channels?

A: The SNAP digital output is likely connected on the wrong side of the loads. Remember that all four channels share one fuse; thus one side of each output is common with one side of all the others. If the module is on the wrong side of the load, any one channel is effectively connected to all four. If the output is a SNK type, try switching to a SRC type. In AC applications, reverse the module wiring.

Q: I keep having failures on one channel of my SNAP output module. Why might this be happening?

A: Failures of only one of the four output channels would indicate a problem with the load being driven by that channel. Make sure that the load characteristics, including transient characteristics, do not exceed the capabilities of the module. Also be sure that the module is properly transient protected, using either an R-C snubber (AC) or a commutating diode (DC) across the load. Modules may also be protected through the use of transient voltage suppressors across the module itself.

SNAP Analog Troubleshooting

SNAP analog modules require a fairly substantial amount of current due to their on-board isolation power inverters. Because of this, it is important to make certain that the entire SNAP installation is supplied with 5.0 to 5.2 V, even while under full load.

See Opto 22 form #1403, *SNAP I/O Wiring Guide*, for help in determining the full load required for an I/O unit, which includes the brain or on-the-rack controller and all modules. Insufficient power supply could cause symptoms ranging from module "drift" to random resets and communication

problems on the brain. The SNAP equipment is designed with a fail-safe voltage watchdog feature that inhibits operation when power supply voltage levels get too low, thus eliminating the possibility of unintentional output or input. Opto 22 offers DIN-rail-mountable power supplies for use with SNAP I/O systems.

Keep in mind that unless you purchase an isolated module, the channels on a SNAP input or output module are not isolated from one another. Make certain that any transducers or equipment that these modules are used with are floating, isolated from local earth ground. If the equipment is not floating, make certain that the two pieces of equipment being connected are at the same ground potential in order to eliminate the possibility of a ground loop through the module. A ground loop through the module could result in almost anything, from inaccurate readings to catastrophic failure of the module.

SNAP analog modules, like any high-level electronics, require protection from electrical noise in high-noise environments, such as installations near arc or plasma equipment or AC inverters. If the SNAP analog system is to be installed in such an environment, be certain that the system is enclosed in an appropriate enclosure. Opto 22 has several documents available that discuss grounding and shielding practice, noise mitigation, and electromagnetic compatibility:

- Grounding, Shielding, Noise, and Compatibility (Opto 22 form #TN9603)
- Grounding and Wiring Practices (form #TN9603A)
- Operational Interferences and Noise (form #TN9603B)
- Interference Generation and Compatibility (form #TN9603C)

SNAP Serial B3000 Brain

Serial B3000 Brain Applications

NOTE: This section covers the B3000 brain, which communicates serially. For information on SNAP brains that communicate over an Ethernet network, see Opto 22 form #1460, the SNAP Ethernet-Based I/O Units User's Guide, available on our website.

Q: What is the B3000 brain?

A: The B3000 brain is an independent I/O processor for use with SNAP I/O systems on a serial network. The B3000 brain mounts to a SNAP rack and can address up to 32 digital and 32 analog I/O points. It offers the same event reaction and PID control capability as Opto 22's mistic Remote Multifunction Bricks. The B3000 communicates at rates up to 115.2 Kbps and offers a choice of either 2-wire or 4-wire RS-485. It provides analog (input) resolution of 15 bits.

Q: What protocols does the B3000 support?

A: The B3000 supports mistic I/O and Optomux I/O protocols. The protocol is jumper selectable on the unit.

Q: How is the B3000 organized?

A: The B3000 is functionally equivalent to four separate, independent, 16-channel brain boards. It occupies four consecutive addresses (Base, Base+1, Base+2, and Base+3). The first two addresses (Base and Base+1) are digital and the last two addresses (Base+2 and Base+3) are analog. Each of these logical brain boards can address up to 16 channels of I/O for a total of 32 digital and 32 analog channels. However, the rack and modules selected will determine the maximum number of I/O channels possible for each B3000/rack combination.

When the B3000 is jumpered for the mistic protocol, it functions as two mistic Digital Multifunction brain boards (for example, the G4D16R), and two mistic Analog Multifunction brain boards (for example, the G4A8R).

When the B3000 is jumpered for the Optomux protocol, it functions as two B1 digital brain boards and two B2 analog brain boards.

Q: How do I use the B3000?

A: The B3000 can be used directly with a PC, with an Opto 22's mistic controller running an OptoControl™ strategy, or with an Opto 22 controller running an ioControl Professional (R7.0a or newer) strategy.

When used with a PC, the PC requires an Opto 22 PCI-AC48 serial adapter card (PCI bus), an AC37 serial adapter card (ISA bus), or an AC38 external RS-232 to RS-485 converter. Communications are handled using the mistic protocol drivers from the OptoDriver Toolkit. Extremely adventurous people may consider writing their own low-level drivers for the B3000; in this case, it supports the full range of mistic A/D commands found in the Opto 22 mistic Analog and Digital Commands Manual.

Q: What are the PID capabilities of the B3000?

A: The B3000 can perform PID (proportional integral derivative) control on analog points only, and only between analog inputs and outputs on the same logical analog brick address. It cannot perform cross-address PID, for example, TPO control of a digital output based on an analog input, or PID using an input on one analog I/O unit address to an output on a different I/O address. A maximum of 16 PID loops can be configured on the B3000. Nominal update times are 100 ms for 1–8 loops, 200 ms for 9–16 loops.

Q: What are the event-reaction capabilities of the B3000?

A: The B3000 brain board can perform the standard mistic multifunction event-reactions, but these event-reactions are restricted to operation between I/O points on the same logical address.

Q: Can the B3000 be used as an independent processor?

A: Yes. The brain's built-in event-reaction capability essentially makes the B3000 into a simple-state machine, with some expanded "time-based-state" capability provided by counters and frequency inputs, as well as analog input levels.

Serial B3000 Brain Troubleshooting

NOTE: For a SNAP Ethernet-based brain, see the Troubleshooting chapter in Opto 22 form #1460, the SNAP Ethernet-Based I/O Units User's Guide. This form is available on our website.

If you are receiving communications errors, see the following section. If you have no communication, see "No Communication" on page 33.

Communications Errors

1. Make sure that the 5 VDC power supply is secure, between 5.0 and 5.2 volts DC, and has no ripple. This should be checked at all SNAP brains and brain boards, across a capacitor on the mounting rack itself, not across the power supply terminals. If possible, inspect the power supply voltage with an oscilloscope, instead of using only a multimeter. Multimeters sometimes do not catch fast AC signals and transients.
2. Make certain the 5 VDC supply common is not connected to earth ground. Also make sure that the COM terminal on the RS-422/485 is not connected to earth ground, and that any shields attached to this terminal are also non-grounded. If a communications wire shield is grounded, it must not be terminated on any of the brains.
3. If more than one 5 VDC power supply is used, make certain that all the commons are connected together. Normally this is done through the logic ground or COM terminals on the communication lines.
4. Make sure the communications cable is daisy-chained from brain to brain; no Ts are allowed under the RS-422/485 specification.
5. Make certain both ends of the communications cable are properly terminated. The last brain on the physical link must have communication jumpers 1, 4, and 7 installed. Termination switches on mistic controllers should be set to "TERM YES."
6. Make sure that shielded twisted-pair cable is used for communications links. If the shield is to be earth-grounded, make sure it is not also connected to logic ground and that another conductor is used for logic common. If the shield is used for logic common, make sure that it is tied into all the logic ground/logic common terminals, but not earth ground.
7. Make sure the communications pairs are not crossed when using 4-wire communication. In some types of cable, one wire from each pair is the same color. This makes it very easy to get those wires mixed up. If the jacket and shield are stripped back far enough, it will become obvious which wire belongs to which pair, unless the cable is not twisted pair like it should be.
8. Try running the system at a slower baud rate.
9. Try to test out the system using the OptoControl or ioControl debugger. These utilities have error trapping ability. Often, the errors received can help determine where the problem might lie. If the debuggers work properly, the problem is likely to be caused by the control strategy, especially where serial communications to third-party devices are being used and are configured improperly.
10. Contact Opto 22 Product Support.

No Communication

1. Make certain that the baud rates and addresses are set correctly. No two brains on the same network should have the same address, and all brains (plus the host device) must be operating at the same baud rate. If you see receive lights flickering on the brains but do not get transmit lights back, the problem is likely an incorrect baud rate or address setting on one or more brains.
2. Check the polarity of the + and – communication lines. If you have one or more receive lights stuck on, this is likely the cause.
3. Re-check the communications wiring. You can check the communications wiring in a multidrop system simply by measuring the impedance across the + and – lines of each wire pair. If the last brain is terminated properly, you should see about 220 ohms. Make certain that in a multidrop system, only the last physical brain has termination jumpers installed.
4. Make sure that CTS handshaking is disabled on the host, or if that is not possible, jumper RTS to CTS. If RTS/CTS handshaking is enabled, the host may not even transmit on the serial data link. CTS handshaking is by default disabled on mistic controllers.
5. If the host is not a mistic controller, make sure that there are no port or IRQ conflicts on the host when using the AC422AT or the AC24AT. If the host device is a PC, it is possible to verify the operation of the RS-422/485 port by jumping TX+ to RX+, and TX- to RX- (TO and FO on Opto 22 cards). A communications program such as HyperTerminal can be used to communicate with the port; in HyperTerminal, make sure that the local echo is turned off. Once started, anything typed on the keyboard should be displayed on the screen. If it is not, there may be a hardware or configuration problem with the communication port. Also remember that Opto 22 ISA serial cards, such as the AC422AT and the AC24AT, do not use standard communication port base addresses or IRQ lines for COM3 and COM4. Make sure that the host software is using the correct base address and IRQ.
6. Contact Opto 22 Product Support.